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EDITORIAL.

IN this number of the Journal will be found a valuable report on roselle fibre cultivation from the pen of Mr. G. E. Henning, Manager of Sweet Kamiri Estate, Sungei Siput, Perak. The subject matter of this article embraces the experience gained on Sweet Kamiri Estate in the cultivation of roselle, from the initial experimental stage of eighteen months ago to the present day when, as Mr. Henning proves, he is able to produce and market roselle at a profit. Buyers of roselle invariably enquire what quantity of fibre can be marketed; they state, they are not prepared to consider the purchase of this commodity in small quantities, but wish rather for consignments running into thousands of tons per annum. The experience of Sweet Kamiri Estate now proves the possible success of this industry; and our thanks are due to the Manager of the Estate for making public the results of his experience, which it is hoped may be of practical utility to others who are planting roselle.

The Department of Agriculture with the help of its Advisory Committee is doing its utmost in suitable cases to bring planters in different parts of the country who are trying, or interested in, similar products into touch with one another, so that experience and knowledge gained may be pooled for the benefit of all. Greater combination in this respect will help all concerned by getting results more rapidly and at less cost and by putting producers in a stronger position to market their produce.

Oil Content.

The results of analysis of the nuts were as follows :—

		Present Sample.	Former Sample.
Average weight of nut	...	7.4 grams.	
Percentage of Kernel	...	32.5%	30%
,, Shell	...	67.5%	70%
Kernel.			
Moisture	...	5.1%	
Oil (Chloroform extract)	...	62.3%	60.6%
Residue (by difference)	...	32.6%	
Oil (calculated on dry kernel)	...	65.6%	
Nut.			
Oil (calculated on whole nut)	...	20.2%	18.2%
Residue.			
Nitrogen (mean of two determinations)		9.9%	

These results are in close agreement with those previously found as is shown in the above table.

The high nitrogen content of the residue would render it valuable as a fertiliser ; it cannot be used as an ingredient of feeding stuffs on account of its strong purgative action.

Expression of Oil.

The kernels, even when pressed cold, yield a considerable proportion of oil and owing to the low moisture content the oil is only very slightly contaminated with albuminous matter.

A further quantity of oil can be obtained by warming the residue and pressing again but the colour of this oil is slightly darker than the cold pressed.

An experiment was made to ascertain the proportion of oil which could be expressed in a small laboratory hand press ;—About 2 lbs. of the kernels were cold pressed, warmed and pressed a second time and the resulting cake analysed.

The results were as follows :—

Moisture	...	3.7%
Oil content	...	13.8% (14.3% on dry cake)
Residue (by difference)	...	82.5%
Nitrogen in residue	...	6.14%

Assuming, therefore, that the original kernels had an oil content of 62 per cent., it will be seen that between 75 and 80 per cent. of the oil has been expressed.

The experiment shows that with an efficient press it would be unnecessary to prolong the heating of the kernels to obtain the maximum yield of oil. Further it was noticed that the difference in colour of the warm and cold pressed oils was only very slight and the Iodine numbers also were practically identical.

Analytical Constants of the Oil.

Table 1 gives the analytical constants of the various samples of this oil.

No. 1.—Present sample of oil from Kota Tampan Estate
No. 2.—Sample of oil from Pekan.
No. 3.—Average figures for Candle nut oil given by Fryer and Weston.
No. 4.—Previous sample of oil from Kota Tampan Estate.

Table I.

	No. 1, Present sample Kota Tampan Estate.	No. 2, Present Sample Pekan.	No. 3, Fryer and Weston Average figures.	No. 4, Previous sample Kota Tampan Estate.
Oil.				
Density at 15.5°C ...	.9293	.9237	.925	.9257
Refractive Index at 20°C ...	1.4773	1.4766	...	...
Saponification value ...	193.3	194.0	193	191.4
Iodine value (Wijs method)	149.0	148.4	164	163.1
Acidity (Oleic Acid per cent.)	2.3	2.4	...	0.4
Fatty Acids.				
Solidifying point (Titer Value)	12.5°C	11.6°C	13.0°C	...
Mean Molecular weight ...	282.4	281.0	...	...

These results show that the figures for the oil both from Kota Tampan Estate and from Pekan are in close agreement ; they also agree with the average values as given by Fryer and Weston for Candle nut oil except as regards the Iodine number which is lower by about 15 per cent. That the Iodine number of this oil varies within wide limits is shown by a further reference to the Imperial Institute communication quoted above, in which analyses of various samples of this oil from different parts of the British Empire are given.

Source of oil.	Iodine number.
Cook Islands (South Pacific) ...	158.5
Hongkong	139.7
Mauritius	151.0

It is also noteworthy that the Iodine number for the present sample of oil from Kota Tampan Estate is also less by about 15 per cent than that found for the previous sample. This lower figure is difficult to explain, it is too large to be due to any differences in experimental methods and can only be ascribed to some variability in the character of the oil.

ROSELLE FIBRE.

HIBISCUS SABDARIFFA VAR. ALTISSIMA.

By G. E. Henning.

THE factors of primary importance in the cultivation of roselle are those of climate and soil. It is urged that no success with this crop can be obtained in really dry weather, although on the other hand, excessive rain is liable to do injury by beating down the plants in their young stage. Planting should be carried out if possible at the commencement of the rainy season.

Soil.—It has not yet been determined what particular type of soil will yield the highest returns of fibre but roselle is known to thrive on loam soils which are capable of retaining a good supply of moisture, and on any other good friable soil. Laterite soils are, however, unsuitable; as is also a light soil deficient in humus. Steep hills should be avoided as Roselle has a small tap root; consequently heavy rains are liable to uproot the plants: in addition to this, the crop is more likely to be damaged by wind storms. Well drained flat land, and gently undulating ground, are suitable.

Planting.—The area to be planted, which must be thoroughly clean and free from weeds, should be changkolled, or forked, to a depth of about 4-6 inches, and after being exposed for a few days to the action of the atmosphere, any surface lumps of soil should be broken up so as to form a fairly even seed-bed. When the climatic conditions are favourable, the seed is drilled in rows about 3 inches apart and the soil lightly raked over; the rate of sowing being about 2.5 lbs. of seed per acre. By planting close, one avoids side branches which break the continuity of the fibre, and thus one obtains better yields per acre,—as there is considerable waste in cultivating for branch fibre. A safe estimate on this system of planting is half a ton of combed fibre, per acre. On Sweet Kamiri Estate up to 1,400 lbs. of fibre per acre from one harvest have been obtained. The cost of upkeep after planting is practically nil as weeding is discontinued after sowing, any weeds that do appear during the early stages of growth being soon shaded out. It will be seen from this that it is very necessary to have the land free from weeds prior to sowing. On Sweet Kamiri Estate two consecutive crops have been obtained over 12 acres without material decline in yield.

Stripping and Retting.—The best time for cutting is just after the plant has flowered *i.e.* at about three months from planting. When the time comes for harvesting all fibre should be stripped from the wood in the field before retting, as this is more economical.

An effective method of stripping is to have about six pegs of hard wood fitted tightly into a good beam, say three feet long on uprights of about 4 feet in order to allow it to be fixed firmly in the ground. The method of stripping the fibre is to give the butt end of the stalk three or four sharp taps until the fibre at the butt-end is freed from the stick,—the ends being gathered in the hands; placing the fibre

round the peg and pulling, when the whole of the fibre will strip from the stick. It is important not to harvest more fibre than can be stripped on the day of cutting, otherwise the material becomes dry and it is then extremely difficult to separate the fibre from the stick. It would appear that the best time for harvesting is after rain, as the fibre comes away more easily from the stick than it does during a dry period. The retting tanks should be near a stream to facilitate the washing of the fibre after retting. Retting takes from eight to ten days. The material should be inspected on the eighth day and removed from the tank if sufficiently retted, but if not, left for another day or so until the process is complete. The cultivator is warned of the danger of over retting, which causes the fibre to be weak and brittle. A recent report by a London broker on one sample of fibre submitted indicates this danger. The broker in question stated..... "but part rather weak caused probably by being over retted." The fibre while in the tank is kept submerged in the water; this is easily done by placing heavy jungle timber over the fibre. The fibre after being removed from the tank, is thoroughly washed in running water, if possible, and care taken to see that all foreign matter is removed during the process of washing. The next operation is sundrying, after which the fibre is combed and baled, when it is ready for shipment. It is not essential to comb the material but it is to be recommended as a very much higher price is obtained.

Costs.—The following costs are based on Roselle being grown as a catch crop with a yield of half a ton per acre, per crop.

	cts.	
Tillage to a depth of six inches, harrowing sowing and other charges in bringing the crop into bearing	.65	per lb.
Cutting and Stripping	2.00	,,
Retting	2.00	,,
Baling	.10	,,
Total cost on Estate exclusive of cartage and freight, etc.	4.75	,,

i.e. $106.40 per ton.

The above figures are the actual costs on Sweet Kamiri Estate, but do not include the charges for erecting tanks or the collection of seed, as this is infinitesimal.

The freight on 1 ton of fibre from Sungei Siput to London is as follows:—

	$ c.
Rail freight Sungei Siput to Penang ...	11.52
Charges receiving, etc. rail into store ...	3.20
Insurance, premium and stamp (Insured for £35)	1.98
Steamer freight to London and stamp ...	28.00
Charges of receiving, storing, forwarding and Shipping	9.60
Bills of lading and stamp	1.50
Total ...	55.80

Making an all-in cost c.i.f. London of $162.20 or $81.10 per acre. The above figures presume effective baling at 50 cubic feet per ton, which is the allowance given by shipping Companies. The acquisition of a baler is therefore essential for economical marketing.

The reports received from London on samples of fibre submitted are distinctly encouraging. The following abstracts from reports may be cited as typical :—

(*a*) London, 29th September 21. "Material is of a jute nature but stronger. We value Samples as follows :—

A 'Sample uncombed valued about	...	£20 per ton
B 'Sample combed about	...	£30 „
Waste from 'B' value about	...	£15 „

(*b*) The value of this fibre on the 8th February was about £28 per ton as against the value of jute at £24 or so per ton, and you will remember that the Sample you supplied was not of first quality."

(*c*) 8.6.22. "The sample is of excellent colour, good length..... it (roselle) is always in demand and present value is about £35 per ton. It should be shipped in press packed bales about 400 lbs. gunnied and roped."

The amount of combings is very small, not exceeding 2-3 per cent. of the total crop. Preliminary advice from London of the first ton shipment (Sent on 4th June) states that the firm price would be about £35 per ton.

The profit therefore amounts to $133 per ton or about 75 per cent.

In further explanation of market price, it should be pointed out that the price of jute has varied in the last year from £24-£38 per ton, the price having shewn a steady rise during the year under review.—*Straits Times.*

NOTE ON INDIAN HEMP.

THE true hemp (*Cannabis sativa*) is not grown in India for fibre. Practically the whole export of Indian hemp consists of the fibre of the Sann Hemp (*Crotalaria juncea*), though small quantities of Sisal Hemp are also exported.

Sann Hemp is, of course, a leguminous plant and like Indigo combines the advantages of a green manure with those of a revenue crop.

A special enquiry was instituted by the Department of Statistics India, in 1917, with a view to arriving at an estimate of the Indian production of hemp fibre. The total area under hemp was given as 785,300 acres with an average outturn of 667 lbs. per acre. The four chief producing provinces were Madras, Bomday and Sind, United Provinces, and Central Provinces and Berar.

The stalks of the plant when cut are soaked in water, then bruised with stones, then re-soaked and so on until the fibre strips off easily. It is only in tracts where water is plentiful that the hemp can be soaked in clean water and the fibre obtained free from mud. In tracts where water is not plentiful the stalks can only be soaked in muddy pools with the result that the dried fibre is found to be impregnated with dust.

The adulteration of Indian hemp has, for several years, been the subject of complaint from importers in the United Kingdom. The Government of India came to the conclusion that it was neither practicable or necessary to have recourse to legislation in the matter. It is understood that the present system, by which the buyer relies on the established private marks of the better known shippers to guarantee him consistent grading, works satisfactorily. In Bombay hackling or combing is already done on a fairly extensive scale and the industry has received an impetus from the improved prices obtained for combed hemps. The hackling has to be done by hand as no suitable machinery exists. The results of the combing are said to be :—

(*a*) The fibre is freed from dust.

(*b*) The fibres are evenly retted by the combs and each bundle or hawk after combing contains fibres of nearly equal length.

(*c*) The short ends of the hemp are combed out as Tow.

The total export of raw hemp from Calcutta in 1918-9 was 489,420 cwt. valued at Rs. 14,679,622. The United Kingdom is by far the biggest importer followed by the United States of America and France. The Sann Hemp exported from Calcutta is classed in the trade under three grades :

(1) Benares Sann Hemp,
(2) Green or Raigarh Hemp
(3) Bengal Sann.

Normally about 85 per cent. or 85,000 bales (350 lbs. each) is classed as Benares Sann Hemp. The bulk of the export trade is handled between October and May.

The standard qualities of each grade as exported from Calcutta are as follows :—

Sann Hemp { No. 1, No. 2, No. 3, No. 4

Green Hemp { No. 1, No. 2, No. 3, Tow

Bengal Sann { No. 1, No. 2, No. 3

Similar classifications are adopted at Bombay, where the export is about 80,000 bales of 3¼ cwt. each, and Madras.

At the time when the shortage in flax was being severely felt, the use of suitably prepared Sann hemp for flax in canvas was advocated by the Fibre Expert to the Government of Bengal. The uses of Sann hemp would extend to all the coarser articles which have hitherto been made from flax, such as hose pipes, belting and canvas.

Prior to the war the United Kingdom's requirements of hemp were mainly supplied (in order of importance) by the Philippine Islands, New Zealand, India, Russia, Italy and Germany. These imports included true hemp from Russia and Italy, Manila hemp, (*Musa textilis*) from the Philippines, Sann hemp from India, New Zealand hemp (*Phormium tenax*) from New Zealand and 'Mauritius hemp' (*Furcroea gigantea*) from Mauritius. True hemp fibre is a satisfactory substitute for flax and, except for the finer linens, is used for the medium grades of nearly all goods commonly made from flax. It is also largely used for cordage, ropes and in the manufacture of carpets and rugs. It has been pointed out that it is not unlikely that the world will look to countries like India for the supply of fibres which may be used as substitutes for the European hemp crops.

(Abstract from Supplement to the "Indian Trade Journal," May 30, 1919, D.A. 831/22).

Note.—Sann hemp has been grown quite successfully in Malaya on a small scale on undulating land.

L.L.B.

MODERN FACTORY PRACTICE IN THE PREPARATION OF PALM OIL.

Introduction.

THE following is an abstract of an important communication by Ir Jhr F. C. van Heurn, Chief chemist at the General Experiment Station of the A.V.R.O.S., entitled "Proposed arrangements for Palm oil factories." The original paper in Dutch was published in 1921 in General Series No. 10 of the publications of that institution, but an English translation was kindly placed at the disposal of the Department of Agriculture by the author.*

In view of the importance which it is hoped the African oil palm will assume as a crop in this country in the future, it has been considered advisable to abstract the report in some detail, in order that those interested may become acquainted with the latest developments regarding the production of this oil.

The report deals only with the preparation of Palm oil, that is the oil present in the pericarp or flesh of the fruit, the preparation of palm kernel oil, the oil present in the kernel, is not considered.

Development of Industrial Preparation.

The industrial preparation of palm oil may be regarded from two standpoints, namely the production of a medium quality oil, containing varying proportions of free fatty acids, suitable for the manufacture of soaps, candles and lubricating greases, or an oil with the minimum quantity of free fatty acids which can be used for edible purposes.

It had been established by the Germans some years ago that palm oil of low acidity (1-2 per cent. free fatty acid) could be used not only in the manufacture of edible oils and fats, but also formed an excellent basis for the preparation of margarine or substitute butter.

This was also confirmed by the findings of the 1916 Committee on Edible Oil producing Nuts and Seeds.

> "Palm oil so improved in quality as to be edible is a distinct possibility, but is not likely to be available in large quantities for some years. If palm oil of high quality could be produced, its texture and other qualities will probably make it at least as valuable for margarine as coconut or palm kernel oils."

As regards the adoption of this oil for use in margarine little has been accomplished up to date, but, as stated in the report quoted, this is due to the fact that the quantity of such palm oil has been limited, since factories erected in the past have not been designed with the idea of producing a high quality oil.

In the case of palm oil there is one condition of paramount importance which must be fulfilled, if the manufacture of edible oil is to become a possibility, namely the necessity for dealing only with fruit which is fresh and undamaged. Fruit, which has remained too

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* Compare Agricultural Bulletin Vol. IX No. 2 page 103 "The African Oil Palm in Sumatra" by J. N. Milsum.

long on the stems, or been allowed to remain on the damp ground, or stored in heaps is of no use for this purpose, since under these conditions fermentation takes place which results in the decomposition of a certain amount of the oil.

The oil present in the ripe fruits is practically neutral and experiments have shown that it is possible to extract the oil as such on an industrial scale by preliminary heating of the fruits. In the following table (Table I) the results of seven of these experiments are given, in each of which about 20 lbs. of fruit were expressed in a small hydraulic press. From these figures it will be seen that the amounts of free acid are only between 1.1 and 1.6 per cent. except in experiment No. 7 in which damaged fruit was used, when the acidity rose to 5.6 per cent.

Further it appears that the method of heating the fruits, whether in boiling water or an autoclave, is immaterial. Though it was expected that fruit heated in boiling water or steam would increase in weight by reason of absorption of water, the experiments show that the contrary is true.

Nevertheless dry heating is advised in actual practice in order to eliminate the maximum quantity of moisture.

TABLE I.

Experimental Pressings with whole Fruits.

Details of treatment and time elapsing between collection and expression.	Mode of heating.	Weight of fruits before heating.	Weight of fruits after heating.	Loss during heating.	Acidity of oil after filtration.
		lbs.	lbs. ozs.	ozs.	per cent.
About one day ...	About five minutes in boiling water.	22	21 13	3	1.5
Do. ...	In autoclave at ½ atmosphere pressure.	22	21 14	2	1.3
Spread out for two days.	Dry in an aluminium boiler.	22	21 13	3	1.6
Do. ...	Dry in iron pan ...	22	21 11	5	1.1
Bunches with adhering fruit, loose fruits pressed after six days.	In autoclave at ½ atmosphere pressure.	20	19 14	2	1.3
Fresh fruit detached from bunch and spread out for four days.	Do. ...	22	21 14	2	1.5
Bruised fruits pressed immediately after gathering.	Do. ...	22	22 3	+3	5.6

The necessity for dealing only with fruit which is ripe and undamaged is shown by the following experiments:—About 132 lbs. of ripe fruit were divided into four portions and treated as follows:—

1. 22 lbs. spread out on a cloth over a wooden framework, all fruits separate.
2. 22 lbs. spread out in the open, imitating as far as possible fruit lying on the ground in a plantation.
3. 44 lbs. heaped up in a box.
4. 44 lbs. heaped up in a box and sprinkled with water three times a day.

After a week the four separate portions were pressed and the acidities of the resulting oils are shown in Table II below:—

TABLE II.

Ref. No.	Mode of Storage.	Acidity per cent.
1	Dry and separate	3.5
2	On the ground in the open	4.5
3	Dry in a box	7.7
4	In a box sprinkled with water	10.1

These results show the necessity for designing a factory of a suitable type if an edible oil of high value is to be obtained. For estate purposes it is considered that such a factory should be erected, so that high quality palm oil can always be manufactured.

Although it is scarcely possible to form an idea of the actual requirements of such a factory from descriptions of plants already working, special reference will be made to one, since it will be seen later that many of the problems associated with the industrial preparation of a high class oil have been worked out in that factory.

The factory which belonged formerly to the "Syndikat fur Oelpalmen Kultur" is at Maka in the country formerly known as German West Africa. The factory which is near both river and railway consists of three buildings. The first contains the boiler house and engine room, in which are two steam engines of 175 H.P. and 75 H.P., the smaller engine being used for working the dynamos required for lighting purposes and as a reserve. Steam is raised by burning the residues from the oil presses and the remains of the palm bunches after removal of the fruits.

The second building, which consists of three floors and is entirely constructed of concrete, contains the plant required for the preparation of the oil. The detailed list is as follows:—

6 Hydraulic presses for whole fruit and 2 for pulp

4 Depulping machines

4 Nut crackers with sieves

2 Filter presses

4 Settling tanks

1 Hot chamber for drying palm kernels.

The third building contains stores and offices.

The method of working is as follows:—The fruits are removed from the bunches by beating, sorted by sieving and conveyed by an elevator to the top floor, where they are placed in boilers furnished with superheated steam coils. After heating, the fruits are transferred to the hydraulic presses on the floor below in which they are subjected to a pressure of about 1 ton per sq. inch. The expressed oil is run into settling tanks, thence pumped to the third floor and passed through a filter press.

After removal from the hydraulic presses the fruits are treated in depulping machines and the nuts separated. The pulp is then further pressed after which it is used as fuel for the boilers. The nuts are dried in a hot chamber and then cracked, the shells and kernels being separated by flotation in brine or clay suspended in water, in which the kernels float while the shells sink. The kernels are then dried for export.

This factory can treat in one week, working 24 hours a day, 345 tons of fruit, (equivalent to 517 tons of bunches), producing 64 tons of palm oil and 24 tons of kernels. The yield of oil calculated on the whole fruit is therefore about 18.6 per cent.

Application of the General Principles of Oil Expression to Palm Oil.

Although the broad principles underlying the preparation of palm oil are the same as for other oil seeds or fruits, namely the reduction of the raw material to a fine condition, followed by heating and pressing, it will be seen that the details require some modification.

Thus there can be no preliminary crushing of the whole fruit on account of its character, and the presence of the kernel which contains a different oil. The heating too, which is generally to facilitate expression by reducing the viscosity of the oil, is also a very important feature of this process, since upon its efficiency depends to a large extent the freedom from acidity and consequently the value of the oil.

The expression must also be carried out carefully, since with such a soft fruit there is a tendency for the oil to squirt during expression (especially if open type presses are employed) thereby forcing out a certain amount of cellular material, which will ferment and cause decomposition of the oil.

Also on account of the character of the fruit it is of great importance to press as rapidly as possible after separation from the bunch, and for this purpose a continuous machine, such as the Anderson Oil Expeller, is recommended for the preliminary pressing.

With regard to the use of an Expeller, the main idea is not to reduce the pericarp of the fruit to pulp, but to submit the whole mass to a uniform pressure in order to reduce the oil content as far as possible before passing the material through the depulping machines. If the fruits were depulped without such a preliminary pressing, it would mean that the same quantity of pulp would be mixed with a larger quantity of oil, thereby increasing the chances of the latter being contaminated.

Expellers for use in palm oil factories should be much larger than those usually employed in the treatment of copra and small oil seeds, since the size of the discharge opening will have to be at least as large as a nut and the diameter of the screw about 40 inches. The mass as discharged from the expeller consists of nuts surrounded by partially crushed pulp, and is then treated in a depulping machine. These machines consist of a series of revolving knives or saws which strip the pulp from the nuts. After separation the pulp is heated before the final pressing in order to dry it and to facilitate the expression of the oil. If the wet pulp were subjected to the high pressures usually employed in oil pressing (about 2-3 tons per sq. inch) a large amount of cellular matter would be expelled with the oil. The objection to this is the fact that this cellular matter begins to ferment almost immediately, thereby increasing the acidity of the oil.

Summarised briefly the chief points to be noted in the preparation of edible palm oil are :—

(1) The selection of ripe and undamaged fruit.
(2) The preliminary heating of the fruit.
(3) Continuity of working.
(4) The drying of the pulp previous to the second pressing.

Consideration of Machinery Required.

Having considered the main principles involved in the preparation of an edible palm oil an attempt will now be made to describe in outline the machinery required ; taking as a basis for calculation an estate of 5,000 acres in full bearing with palms planted 30 ft. apart on the triangular system the following figures are obtained :

Number of palms per acre...	55
Total number of palms	275,000
Maximum number of bunches per palm per annum	12
Total maximum per annum	3,300,000
Maximum number of bunches every five days ...	45,200
Hanging distance required per bunch	1¼ ft.
Hanging distance required for five days harvest ...	19,000 yds.

The bunches would be harvested when the fruits are almost ripe and still attached to the stems. The 10,000 bunches which may be taken as a maximum for a daily harvest would be transported to the factory in Decauville trucks, fitted with cross bars on which the bunches would be hung. On arrival at the factory the bunches would be transferred to sheds also fittted with numereus cross bars, arranged in four sets one above the other. The fruits would be hung on the cross bars till ripe which would take about five days. It is estimated that two sheds each 110 yards by 28 yards, with cross bars 3½ ft. apart, would be required for the maximum five days' crop. Between the cross bars planks would be placed to enable the coolies to walk round and knock off the ripe fruits. This work is easy and can be carried out quickly if the bunches are hanging breast high and the fruits allowed to fall. When as many as possible of the fruits have been knocked off, the bunches would be transferred to a cable conveyer, working at right angles to the lines of cross bars, and taken to a shed to be split up for the removal of the remainder of the fruits. Three endless belts running along the bottom of these sheds would convey the fruits to the expression machinery; it would be necessary to have other coolies stationed beside these belts to remove rotten or damaged fruits.

Each belt would supply one set of machines comprising a boiler for heating the fruits, an expeller and a depulping machine, the respective capacities of which would have to be calculated. According to the above figures each of the belts would have to convey a maximum of 7½ tons of fruits per day assuming that each bunch yielded about 11 lbs., but in practice the weight would probably not exceed 4 tons. The endless belts convey the fruits to the heaters which also act as driers, and through which the fruits pass on a series of endless belts fitted one above the other. The temperature of the chamber would depend upon the speed of the belts which can be regulated ; the greater the speed the higher the temperature, bearing in mind that fruits can only withstand a temperature of 160°C without deterioration of the oil.

The fruits would then be transferred to the filling troughs for the expellers. Theoretically the whole of the oil in the fruits could be expressed in the expellers as it is quite possible to alter the pressure from the time when the fruits fill the chamber to the time when the nuts touch, but since the reduction in volume, consequent upon the removal of the pulp from round the fruits, is much greater than the volume of oil expelled this result is never attained.

After discharge from the expeller the pulp is crushed, but, as it will be still adhering partially to the nuts, the whole mass must be depulped in one of the many types of depulping machines on the market.

After being separated from the nuts the pulp should be reheated and dried in order to reduce the moisture content, and at the same time to coagulate the albuminous matter, thereby facilitating subsquent expression of the oil. Since the pressure to which the pulp must be subjected in order to obtain the maximum quantity of oil is about 3

tons per. sq. inch, it is important that the pulp should be as dry as possible, otherwise large quantities of albuminous matter will pass out with the oil. This would result not only in a loss of oil held up mechanically when filtering, but the presence of this mucilage tends to set up fermentation thereby increasing the acidity of the oil.

No remarks on the subject of presses are necessary as there are numbers of types working successfully. The residue from the presses is used as fuel to fire the boilers.

The nuts after drying would be broken in a nut cracking machine, of which there are now several useful types. The separation of kernels and broken shells by immersion in brine solution is primitive and it is hoped that before long some more satisfactory method will be available, possibly one designed on the principle of a winnowing machine. The drying of the nuts previous to cracking is essential otherwise the kernels will be spoiled.

The treatment of the second quality fruit, over ripe or damaged, would be carried out in the same way but in a different set of machinery.

As regards the preservation of the oil it has been shown that oil free from mucilage and water will keep well.

The transport of the oil would have to be effected in barrels or tanks, provided of course that the output is not sufficient to warrant a tanker (Tank steamer). Barrels, as in West Africa, could be made in the factory from their component parts but tanks would have to be imported.

It is not intended to discuss more general problems such as that of power but, taking as a basis the 250 H.P. required for the Maka factory, an estate of 5,000 acres producing about 0.6 tons of oil per acre per annum would require about 220 H.P. This power would have to be supplied partly by steam and partly by gas or crude-oil engines.

Having regard to present conditions it is certain that some time will elapse before a factory on these lines is erected. The scheme leaves much to the initiative of the person in charge, who should on no account permit one firm to supply the whole of the plant but should endeavour to make a selection of the best types of the various machines and then combine them.

C.D.V.G.

NOTES ON THE FERTILISING VALUE OF TAPIOCA REFUSE.

By C. D. V. Georgi.

AN enquiry has been received regarding the suitability of refuse from tapioca factories as a fertiliser.

This refuse consists of the outer skin, fibre and other debris remaining on the sieves through which the pulped roots are passed after maceration and grinding with water.

The refuse is a greyish white powder containing a proportion of short fibres.

The results of analysis expneesed in parts per cent are as follows :—

Moisture	11.6
Ash	28.7
Organic and volatile matter (by difference)	59.7
Nitrogen	0.61
Potash (K_2O)	0.58
Phosphoric acid (P_2O_5) ...	0.56

From these results it will be seen that the refuse has only a small fertilising value; the total plant foods, nitrogen, potash and phosphoric acid calculated on the dry material amounting to less than 2 per cent.

Although this refuse would not pay for the cost of transport it could however be utilised as a fertiliser on the estate where it is produced, thereby conserving as far as possible the plant nutrients in the soil.